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# RESULTS OF A PILOT STUDY TO TEST THE EFFICACY OF THREE INSECTICIDES IN PREVENTING ATTACKS BY THE MOUNTAIN PINE BEETLE IN LODGEPOLE PINE

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# Results Of A Pilot Study To Test The Efficacy Of Three Insecticides In Preventing Attacks By The Mountain Pine Beetle In Lodgepole Pine


## ABSTRACT

A pilot study was undertaken to test the efficacy of three Insecticides: Lindane, Sevin and Dursban in preventing attacks by the mountain pine beetle in lodgepole pine. Methods used in the selection, plot design and chemical application are described. Results indicating success or failure of the insecticides used are included.


## INTRODUCTION

During the past quarter century, the mountain pine beetle, Dendroctonus ponderosae Hopkins, has been responsible for killing thousands of lodgepole pine throughout the Intermountain West. Beginning in the early 1950's, the present outbreak reached epidemic proportions during the mid-1960's in most of the lodgepole pine forests of northern Utah, western Wyoming and southeastern Idaho.

Control projects conducted annually throughout the Region, were begun in 1958 on the Wasatch National Forest, Utah. Such projects were concluded in 1970 on the Targhee National Forest, Idaho. In the intervening twelve years literally millions of dollars and thousands of man days were expended attempting to contain or eliminate bark beetle epidemics. These efforts were largely unsuccessful due to the magnitude of the infestations, inadequate funds for both surveys and suppression, and inconsistent control philosophies (Klein, Stipe and Frandsen, 1972).

Beetle populations are now on the decline in most areas. There are, however, portions of several forests suffering widespread killing of lodgepole pine as a result of still active beetle infestations. With the termination of control efforts, these losses in wild stands were accepted as inevitable. However, efforts are now being made to salvage and utilize both older dead and current beetle-killed timber. A continuation of current salvage efforts and implementation of new and refined management techniques for lodgepole stands represents useful and effective defensive tactics against the mountain pine beetle.

These defensive actions may, however, be unacceptable in areas of high-value timber. In campgrounds and on small private holdings, it may be more desirable to exercise offensive actions to prevent bark beetle attacks. In the past, some such efforts have met with success. Swaine (1965) has shown Lindane to be effective in preventing attacks

by the western pine beetle, Dendroctonus brevicomis Le Conte, in ponderosa pine. Lindane, Sevin and Dursban have also shown effectiveness against the mountain pine beetle in ponderosa stands in Colorado and in lodgepole stands of California and Idaho (Smith, McCambridge and Trostle, 1975).

A pilot study to further test the efficacy of Lindane, Sevin and Dursban was conducted in Region 4 during 1975 (Klein, 1975). For that effort, these three chemicals were applied as 2 percent oil-formulated sprays. Subsequent evaluations, however, have shown that the diesel oil carrier produced phytotoxic reactions in many of the treated trees (Rogers, 1976). As a result, a similar project was carried out in 1976 using these three chemicals in water formulation instead of oil. This paper reports the results of that study.

## TEST SITE

The 1975 pilot study was conducted on the Targhee National Forest, Idaho, near the Island Park Ranger Station. The actual site was in Buffalo Campground where a 1974 population trend study on mountain pine beetle indicated an attack density of 13 new green infested trees per acre. The 1975 results for the same plots indicated 25 new attacks per acre. This data and aerial survey sketch maps indicated that the Island Park Ranger District would be a suitable area for the 1976 test. In the spring of 1976 a new pilot study area was selected along Sawtell Peak Road, approximately 7 miles north of the Island Park Ranger Station. Criteria for selection included: (1) a relatively high number of trees attacked in 1975, (2) a suitable number of unattacked trees to provide both treatment and check trees, and (3) road access for the truck carrying the pumps.

Individual tree selection was made according to the following criteria: (1) treatment trees must be at least 9.5" dbh, (2) treatment trees must have within a 33' radius, a minimum of 2 non-attacked trees at least 9.5" dbh, (3) treatment trees must be at least 33' apart and (4) treatment trees could not be more than 200' from the road (this was for spray purposes only). With these criteria in mind, 300 potential treatment trees were selected in mid-April, 1976. Each treatment tree had at least two checks, and were laid out so that an individual tree could serve as a check for one or more treatment trees (Figure 1).

In early May, the treatment and check trees were measured, recorded and marked. The 300 trees to be treated were labeled with aluminum tags numbered 1 through 300. The checks for each treatment were

marked with fluorescent paint on the portion of the bole facing the treatment tree for which it was serving as a check. This greatly facilitated later evaluation. As noted, some checks had as many as 3 spots, each facing its respective treatment tree. Table 1 lists average dbh for treatment and check trees, plus average number of checks for each treatment.

## METHODS AND MATERIALS

To assure equal attack pressure by the insect, it was decided that the insecticides would be applied to alternating trees, rather than in blocks of 100. For example, Lindane was applied to trees number 1, 4, 7, etc.; Sevin to trees 2, 5, 8, etc., and so on with the Dursban.

Application of spray mixtures was accomplished with two portable, pickup-mounted pumps powered by seven horsepower, 4-cycle, gasoline engines. Each unit had a high pressure pump with mechanical agitator and recirculation system. The only difference between the two units was in tank size and hose length. One had a 100 gallon tank with a 200 foot hose, while the other had a 50 gallon tank and 100 foot hose. Although the pumps were high-pressure type, each was equipped with a gauge so that pressures could be measured and regulated. For this study, the pump, tank and hand operated hose reel were bolted to the bed of each pickup (Figure 2).

Spraying was done with a #4006 Tee-Jet nozzle in a standard spray head, flexible rubber tubing, and a toggle-action shut-off valve attached to a telescoping fiberglass pole (Figure 3). Spray was applied to a height of 25 feet and to the point of runoff on each tree (Figure 4). A spray pressure of 40 psi resulted in an application rate of 2 gallons of mixture per tree. At the end of each spray day the tanks were emptied at the Island Park sanitary landfill and then cleaned with a solution of Nutra-Sol and water mixed at the rate of one pound per 50 gallons. After cleaning this was also dumped at the landfill. Insecticide mixtures were buried after dumping even though daily operations at the dump kept refuse covered.

Spraying began on May 27, with the application of Lindane. The 2 percent solution, mixed in the smaller of the two tanks, contained 6 gallons Lindane (20 percent EC) and 44 gallons of water.

This application, requiring three days, was completed on June 3. On June 9, we began spraying Sevimol-4, a 40 percent suspension of Sevin insecticide in a molasses carrier. This was mixed in a ratio of 2

gallons Sevimol-4 to 48 gallons of water, which also produced a 2 percent solution. Operating both pumps we applied the Sevin in 2 days, finishing on June 10. Again, approximately 2 gallons of spray was applied to each tree. Due to inclement weather, the Dursban application did not begin until June 15. In order to obtain a 2 percent solution, we mixed each tank with 2 gallons Dursban (40 percent EC) and 48 gallons water. Spraying was accomplished in 2 days; however, because of rainy conditions, the second day was not until June 23. As with the other two applications, an average of 2 gallons of spray was applied to each tree.

Personal safety equipment during the project consisted of coveralls, hard hats, face shields and rubber gloves (Figure 5). Rubberized clothing was not considered necessary because of the low dermal toxicity of each of the three water formulated insecticides. As a precaution the coveralls were worn only once, however, before being laundered. Face shields were frequently wiped clean with paper towels due to the falling mist. As an additional precaution, a supply of clean water was carried on each truck for washing eyes, face, or hands, as needed.

## INSECTICIDES TESTED

Lindane is a chlorinated hydrocarbon widely used for a number of forestry applications. It has been registered for use against the balsam woolly aphid, some wood borers, the mountain pine beetle and the southern pine beetle, to list a few. Though slightly more toxic to mammals and birds than carbaryl, it is only about one tenth as toxic as DDT. When applied at registered levels, it has exhibited no adverse effects on wildlife, nor has it shown any phytotoxic properties. Though persistent in soils, the method of application used in this test would seem to minimize the possibility of any environmental damage.

Sevin (carbaryl), a carbamate, is widely used against both agricultural and forest pests. It has been registered against such forest insects as the gypsy moth, tent caterpillars and elm leaf beetle. Though exhibiting good residual properties, it has shown no phytotoxic reactions. At normal dosage rates it has a very low toxicity to vertebrates. It is, however, quite toxic to non-target insects, especially honeybees.

Dursban (chlorpyrifos) is a broad spectrum, organophosphate insecticide used against a variety of economic and household pests. It has good residual properties and is fairly stable. Persistence depends upon such factors as sunlight, alkalinity and temperature. When applied as

recommended, Dursban has low toxicity to birds, slightly more to fish. It is phytotoxic to some plants, but nontoxic to others. It, like carbaryl, is highly toxic to non-target insects.

## EVALUATION

To determine beetle pressure in the test area, 40 ½-acre trend plots were established along the Sawtell Peak Road adjacent to the treatment plots (Figure 6). These plots, set up during and immediately following the application of chemicals, were used to obtain data concerning the incidence of 1975 attacks, 1975 strip attacks, 1974 attacks, and snags (Table 2). In addition, a variable plot (BAF 10) was established within each of these 10-chain plots to obtain green stand data (Table 3).

The evaluation of treatment effectiveness was made by making direct comparisons between treated trees and corresponding checks. Comparisons were made when (1) treated trees were attacked, or (2) check trees but not corresponding treatment trees were attacked. No comparison was made when neither treatment trees nor corresponding checks were attacked. In such an event, the entire group was disregarded.

Trees were counted as newly infested if attacks around the bole occurred in sufficient numbers to kill the tree. Trees were considered to be strip-attacked if the infestation occurred on only one side of the bole. Those trees with pitchouts and those attacked above spray height were recorded as such. Attacks above 25' were verified by examination with binoculars. Subsequent sampling in the spring of 1977 will evaluate brood densities in all trees and determine the condition of treated trees attacked above spray height. Tables 4 through 6 contain test results reflecting numbers of trees attacked by insecticides group, numbers of checks attacked, and percent success for each chemical.

## RESULTS AND DISCUSSION

Study results as shown in Tables 4, 5 and 6 show Sevin to be highly successful as a preventive spray against the mountain pine beetle. The 94 comparisons indicate: 53 not attacked, 1 strip attacked, 3 pitchouts, and 37 attacked above spray height. Classifying those trees attacked above 25 feet and/or with pitchouts as non-attacked, a success ratio of 98.9 percent was achieved.

Lindane was not as successful as Sevin, though a good degree of protection was achieved. Eighty-nine comparisons indicate: 7 attacks, 16 strip attacks, 2 pitchouts, 41 not attacked, and 23 attacked above 25 feet. Applying the above criteria for success, a 74.2 percent success ratio was achieved.

Dursban, unlike the other two chemicals, had disappointing results. The 92 valid comparisons indicate: 57 attacks, 8 strip attacks, 9 pitchouts, and 18 not attacked. No attacks were recorded above 25 feet. This represented a 29.3 success ratio.

At the time the post-spray evaluation was made, many healthy larvae were found in Dursban treated trees which had been attacked. There were however, a number of dead adults found as well. Brood sampling in the spring of 1977 will determine actual attack success.

In comparable testing in the Southeast, Dursban has met with much greater success (Buffam, 1976). For this reason, bark samples were removed from treated and check trees and sent to Dr. U. Eugene Brady at the University of Georgia for residue analysis. The samples, collected on October 1, nearly 3½ months after application, contained Dursban residues averaging 2131 ppm. No measurements were made at the time of application for a comparison figure. However, according to Dr. Brady, the 2131 ppm would provide a lethal dose to the southern pine beetle. There is, apparently, some physiological differences either in the insect or tree species, or both, which accounts for Dursban's lack of success in the West.

Treatment cost on a per tree basis for the study was calculated at $31.32. The cost totaling $9,395 included $988 for chemicals; $277 for equipment, $520 for services (rentals), and $7,610 for salaries and travel. (This figure does not include the salaries of permanent employees.) If, however, the cost of chemicals and equipment, which in this instance were received gratis, or were already on hand, had been included, the total would have been $10,335 -- a cost of $34.45 per tree. (These per tree figures include tree selection, trend studies, and post-spray evaluation.) Operational or commercial costs considering a Sevimol application, and using commercial rates for salaries and pump rental, the cost per tree is reduced to $7.28. For an individual to spray his own trees, other long-term investment items such as poles, spray equipment, etc., would be incurred which would add somewhat to individual tree costs. Also, insecticide costs differ which would add yet another variable to such computations.

## SUMMARY

The results of this pilot study indicate that preventive treatment against the mountain pine beetle under operational conditions is feasible. Costs would probably prohibit such treatments over large tracts of forested land, but in areas of high-value timber, this protection seems quite promising. At the present time, there is good reason to believe a 2 percent solution of Sevin may be suited for registration for this purpose. The prospects for Lindane and Dursban do not appear promising. In spite of the fair showing, the prospects for use of Lindane appear slight because it is one of the chlorinated hydrocarbons. Dursban, on the other hand, while finding much success in other uses, is apparently ineffective against the mountain pine beetle in lodgepole pine.

The preventive spray pilot study conducted on the Targhee National Forest in 1976 was successful in the following ways: (1) it determined that good protection is possible with some chemicals, (2) it demonstrated the feasibility of using chemicals under operational conditions to protect high-value trees, and (3) it provided a basis for future testing which must be done in order to confirm both these positive and negative results.

## REFERENCES


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# APPENDIX

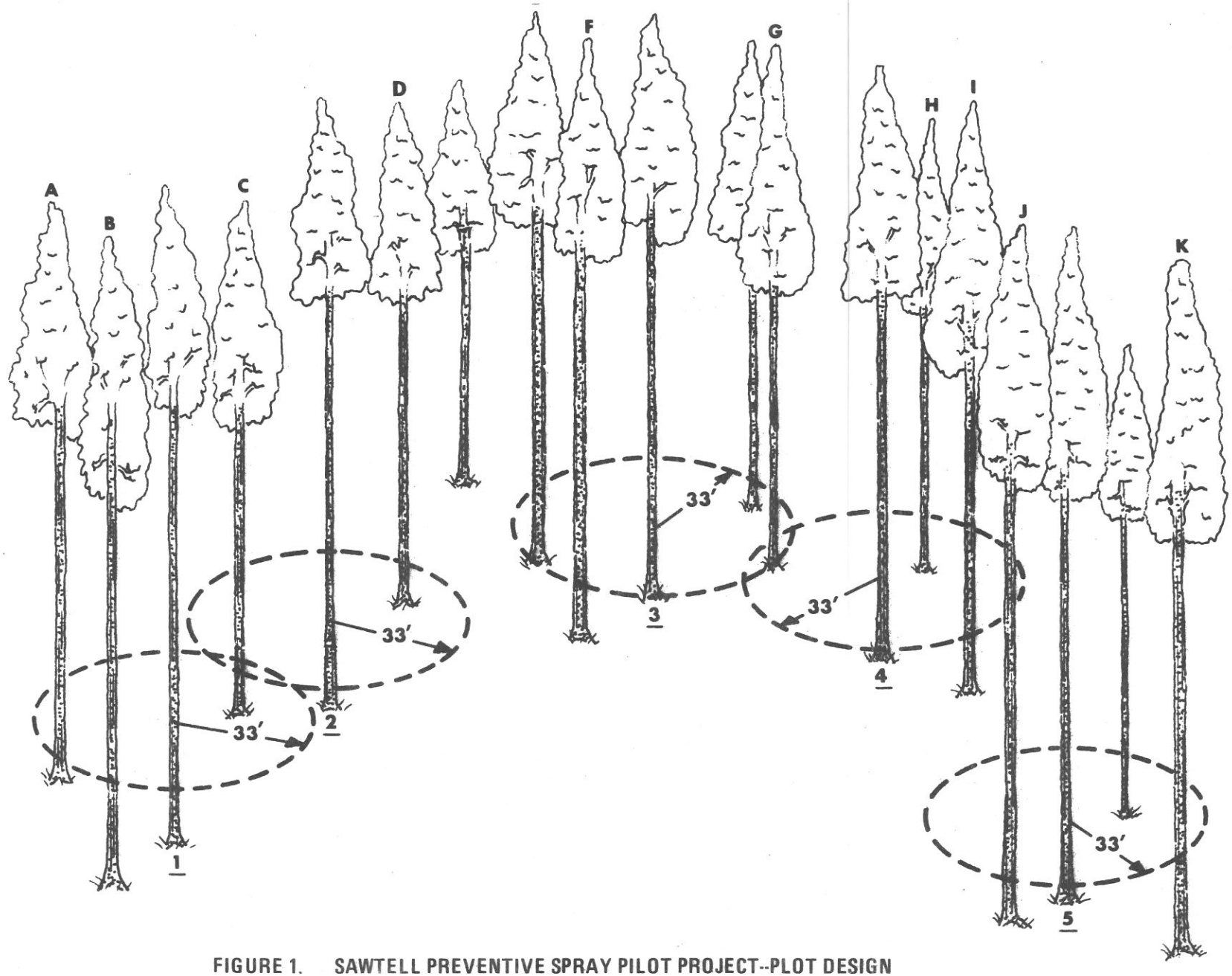


FIGURE 1. SAWTELL PREVENTIVE SPRAY PILOT PROJECT--PLOT DESIGN

In this example, trees No. 1,2,3,4, and 5 are treatment trees. Trees A through K are checks. Trees C and G are "double checks" in that they serve as checks for each of two treatment trees. Those trees not labelled are either outside the plot radius or below 9.5" dbh.

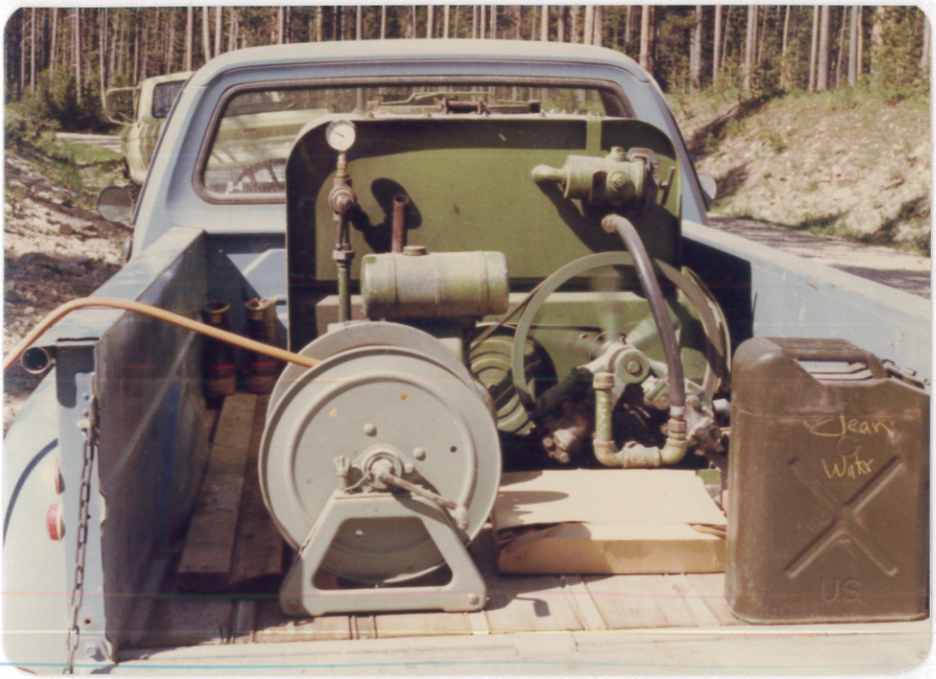


Figure 2. Pickup truck bed showing mounting of tank, pump and hose reel.

Figure 3. Spraying apparatus including spray head, valve and hose attachment.

Figure 4. Insecticides were applied to tree boles to point of runoff.

Figure 5. Spraying of insecticide illustrating application technique and personal safety equipment used.

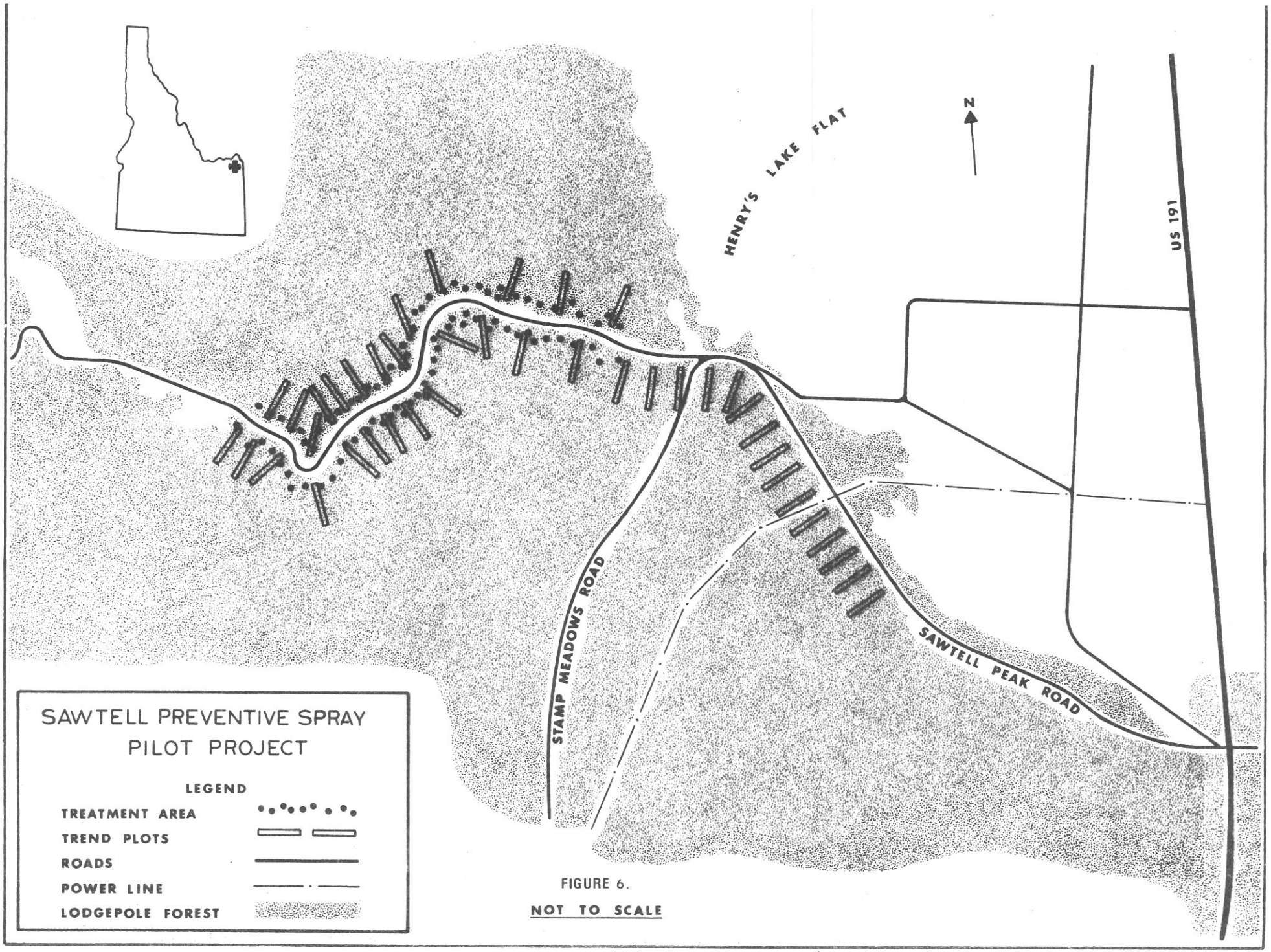


FIGURE 6.

NOT TO SCALE

Table 1. Treatment And Check Tree Comparisons

| | Number Treated | Average dbh (treated) | Number Checks [1/] | Average dbh (check) | Number Checks Attacked |
|---|---|---|---|---|---|
| Lindane | 100 | 12.2" | 562 | 11.5" | 330 |
| Sevin | 100 | 11.9" | 561 | 11.4" | 347 |
| Dursban | 100 | 12.1" | 506 | 11.3" | 321 |

1/ Some checks served more than one treatment tree. Therefore, totaling the three groups would not be valid.

Table 2 Trend Plot Data - Attacked Trees (Data based on 40 ½-acre strip plots).

| Diameter Class | Trees Per Acre | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1976 Hits | 1976 Strips | 1975 Hits | 1975 Strips | 1974 Hits | Snags | Total Dead |
| 6 | 0.10 | -- | 0.05 | -- | -- | -- | 0.15 |
| 7 | 0.50 | -- | 0.10 | -- | -- | 0.20 | 0.80 |
| 8 | 1.35 | 0.60 | 0.80 | 0.25 | 0.05 | 0.75 | 2.95 |
| 9 | 2.90 | 1.25 | 1.00 | 0.30 | 0.15 | 1.50 | 5.55 |
| 10 | 3.05 | 0.80 | 2.45 | 0.85 | 0.50 | 2.35 | 8.35 |
| 11 | 4.45 | 1.10 | 2.65 | 0.80 | 0.95 | 2.25 | 10.30 |
| 12 | 3.05 | 0.85 | 3.90 | 1.30 | 1.40 | 2.70 | 11.05 |
| 13 | 2.40 | 0.20 | 2.90 | 0.65 | 1.05 | 2.80 | 9.15 |
| 14 | 1.40 | 0.45 | 1.75 | 0.15 | 0.90 | 1.60 | 5.65 |
| 15 | 0.70 | -- | 0.45 | 0.15 | 0.45 | 1.10 | 2.70 |
| 16 | 0.60 | -- | 0.20 | -- | 0.25 | 0.40 | 1.45 |
| 17 | 0.05 | -- | -- | 0.50 | 0.05 | 0.15 | 0.25 |
| 18 | 0.05 | -- | 0.05 | -- | 0.20 | 0.15 | 0.45 |
| 19 | -- | -- | 0.05 | -- | 0.10 | 0.10 | 0.25 |
| 20 | 0.05 | -- | -- | -- | 0.10 | 0.15 | 0.30 |
| 21 | -- | -- | 0.10 | -- | -- | -- | 0.10 |
| 22 | -- | -- | 0.05 | -- | -- | -- | 0.05 |
| 23 | -- | -- | -- | -- | -- | 0.05 | 0.05 |
| 26 | -- | -- | -- | -- | -- | 0.05 | 0.05 |
| Total | 20.65 | 5.25 | 16.50 | 4.50 | 6.15 | 16.30 | 59.60 |
| Percent | 34.65 | -- | 27.68 | -- | 10.32 | 27.35 | 100.00 |

Table 3. Green Stand Data - Sawtell Trend 1976 (Data based on 40 variable (BAF10) plots)

| Diameter Class | Trees Per Acre | | | | |
|---|---|---|---|---|---|
| | Lodgepole Pine | Douglas-Fir | Subalpine Fir | Quaking Aspen | Total |
| 6 | 24.19 | 1.27 | -- | -- | 25.46 |
| 7 | 27.13 | 0.93 | -- | -- | 28.06 |
| 8 | 20.77 | 0.72 | -- | -- | 21.49 |
| 9 | 20.37 | -- | -- | 3.39 | 23.76 |
| 10 | 16.96 | 0.46 | 0.46 | -- | 17.88 |
| 11 | 12.22 | -- | -- | 0.76 | 12.98 |
| 12 | 8.91 | -- | 0.32 | -- | 9.23 |
| 13 | 4.34 | -- | -- | 0.54 | 4.88 |
| 14 | 2.81 | -- | -- | -- | 2.81 |
| 15 | 1.43 | -- | -- | -- | 1.43 |
| 16 | 0.36 | -- | -- | -- | 0.36 |
| 17 | 0.16 | -- | -- | -- | 0.16 |
| 18 | 0.28 | -- | -- | -- | 0.28 |
| 19 | -- | -- | -- | -- | -- |
| 20 | -- | -- | -- | -- | -- |
| 21 | 0.10 | -- | -- | -- | 0.10 |
| 22 | -- | -- | -- | -- | -- |
| 23 | 0.09 | -- | -- | -- | 0.09 |
| Total | 140.12 | 3.38 | 0.78 | 4.69 | 148.97 |
| Percent | 94.06 | 2.27 | 0.52 | 3.15 | 100.00 |

Table 4. Post Spray Evaluation Summary

| Insecticide | Attacked All Around | Strip Attack | Pitch Out | Not Attacked | Hit Only Above 25' | No Checks Attacked |
|---|---|---|---|---|---|---|
| Lindane | 7 | 16 | 2 | 41 | 23 | 11 |
| Sevin | 0 | 1 | 3 | 53 | 37 | 6 |
| Dursban | 57 | 8 | 9 | 18 | 0 | 8 |

Table 5. Attack, Non-Attack Ratios[1/]

| Insecticide | Not Attacked | Attacked | Hit Only Above 25' | No Checks Attacked |
|---|---|---|---|---|
| Lindane | 43 | 23 | 23 | 11 |
| Sevin | 56 | 1 | 37 | 6 |
| Dursban | 27 | 65 | 0 | 8 |

1/ Attacked = Strips + Attacks; Not Attacks = Not Attacked + Pitchouts

Table 6. Success Ratios[1/]

| | Not Attacked | Attacked | Percent Success |
|---|---|---|---|
| Lindane | 66 | 23 | 74.2 |
| Sevin | 93 | 1 | 98.9 |
| Dursban | 27 | 65 | 29.3 |

1/ Those attacked only above 25' were counted as not attacked.